This document contains Charting the Course of the Comprehensive Conservation and Management Plan for Tampa Bay: The State of the Bay

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File 2 of 7

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State of the Bay

From the headwaters of the Hillsborough River to the salty waters off Anna Maria Island, Tampa Bay encompasses a rich mosaic of underwater and coastal habitats that support thousands of species of plants and animals. Preserving and restoring these interdependent habitats — even in the face of continued growth — is critical to the bay's future.

Estuaries like Tampa Bay, where salt water from the sea and fresh water from rivers mix, are among the world's most productive ecosystems. More than 70 percent of all commercially important species of fish depend on estuaries at some stage in their development.[1] The bay also attracts a remarkable number and variety of birds and animals that depend on its rich tapestry of habitats and diverse food supply.

As Florida's largest open-water estuary, Tampa Bay spans almost 400 square miles and receives drainage from a 2,200-square-mile watershed more than five times the bay's size.[2] Activity in this watershed has a profound influence on the health of the bay. Nutrients in runoff from the watershed fuel the bay's productivity, but excess amounts of nutrients, as well as contaminants from neighborhoods, industries, cities and farms, pollute the bay.

Achieving a healthy balance of nutrients from the land and sea, and redressing past damage to habitats and protecting them in the future, remain vital to the bay's health. These tasks become challenging in the context of modern growth. As population in the tri-county area surpasses 2 million people, actions we take at home, at work and in our communities increasingly influence the state of the bay.

This chapter explores the state of the bay — as well as the management structure charged with the bay's protection — so that the community can direct future efforts where help is most needed and ensure that increasingly limited public funds are spent in a manner that best benefits the bay and the people who live around it. Restoration is a complex but achievable task that will require a steady focus on ecosystem management. Decisions based on ecosystem needs — those that recognize how individual habitats affect the health of the whole and how fish and wildlife depend upon this network for survival — can prevent costly and less effective piecemeal treatment.

Achieving the goals set out by the Tampa Bay National Estuary Program (NEP) will require a flexible, yet comprehensive, ecosystem management approach that takes into account the overall needs of the estuary. By considering and capitalizing on these differences, ecosystem management goes beyond traditional program boundaries — just as the bay ecosystem itself extends far beyond its visible borders. Thus, a plan based on these principles can integrate actions and policies to better protect the bay's multi-faceted resources.

By focusing less on government-imposed regulations and more on the actual requirements of the bay's living resources, opportunities for producing direct, measurable results that are cost-effective and community-specific can be identified. In this approach, success is measured less by compliance with laboratory standards for water quality than by increases in seagrasses, fish stocks and other biological indicators of a healthy estuary.

The NEP is committed to a course of action that emphasizes ecosystem management as a common-sense approach for protecting Tampa Bay well into the next century.

Water and Sediment Quality

Since the 1980s, local communities have made significant strides in improving water quality in Tampa Bay. The quality of the bay's water and sediments is important to the animals and plants that reside in them, and also affects human use and enjoyment of the bay.

Excess amounts of nutrients and chemicals — some naturally occurring, others generated by humans — can jeopardize the bay's health. The most striking example of this occurred from the 1960s to the late 1970s, when excess nitrogen from discharges of partially treated sewage led to excess algae growth and low dissolved oxygen and light levels in the bay — a condition known as eutrophication. Degraded water quality contributed to seagrass losses by blocking light to the bay's underwater grass beds.

Sediment quality also has been impacted by potentially toxic contaminants carried in stormwater runoff, wastewater and atmospheric deposition to the bay. Studies conducted by the National Oceanic & Atmospheric Administration (NOAA) and the Florida Department of Environmental Protection (FDEP) in the last decade have revealed high levels of these contaminants in sediments at several bay sites, including upper Hillsborough Bay, Boca Ciega Bay and Bayboro Harbor.[3]

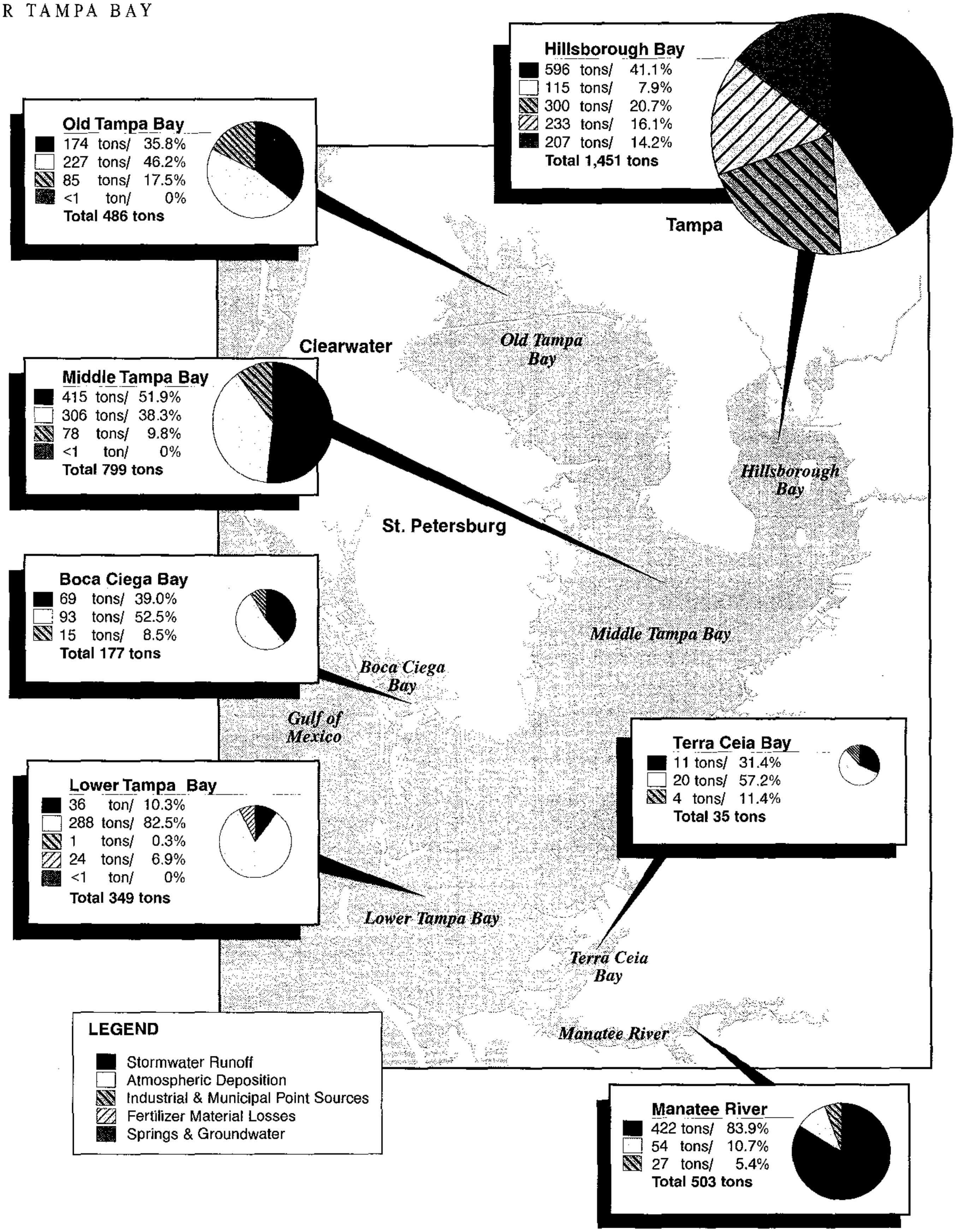
New studies show that atmospheric deposition of pollutants may play a much larger role in the bay's water quality than previously realized. Nitrogen and potentially toxic pollutants, primarily from industrial and vehicle emissions, fall to the surface of the bay and its tributaries or on the land where they are carried to the bay in stormwater runoff. Research financed by the Tampa Bay NEP indicates that almost one-third of the bay's total nitrogen load may come from atmospheric deposition directly to the surface of the bay.[4]

Recent attention also has focused on the problem of sanitary sewer overflows caused by heavy rainstorms that force some municipal treatment plants to shunt raw or partially treated sewage to Tampa Bay. Sewage overflows are of particular concern in St. Petersburg, where low land elevations and rapid population growth have combined to strain existing municipal sewer and stormwater systems. In August 1995, St. Petersburg was forced to shunt more than 15 million gallons of raw sewage into canals leading to the bay when torrential rains caused sewer backups.[5] Corrective actions will be costly and will take time, but they are necessary to minimize associated water quality impacts and allay public concerns about the bay's safety as a recreational and fisheries resource.

Since 1974, the Environmental Protection Commission (EPC) of Hillsborough County has conducted a comprehensive water quality monitoring program in the bay's four major segments. The wealth of data compiled by EPC is the principal source of information for the following status and trends on bay water quality. A benthic monitoring program recently established by the counties surrounding the bay will track trends in sediment quality and the abundance and distribution of bottom-dwelling animals.

Existing Annual Nitrogen Loadings to Tampa Bay by Bay Segment (1992 - 1994 average)

Figure 5



Estimates of existing and future nitrogen loadings to Tampa Bay are presented in Figures 4 and 5. Workshops with local governments and industry are being conducted to determine equitable allocations of the bay's nitrogen management goals to the jurisdictions and sources from which they originate. These commitments will form the basis of an agreement signed by community and agency partners in 1997 to implement the Tampa Bay restoration plan.

Toxic Contaminants

Toxic contaminants represent another primary focus of concern for bay managers. Overall, Tampa Bay has relatively low to moderate levels of most toxic parameters when compared to other urban estuaries.

Toxics of concern, identified in Figure 7, include various trace metals, pesticides, polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs).[15] These substances, some naturally occurring and others synthetic, can be damaging or deadly to marine life when present in sufficiently high concentration. In addition, they have the potential to affect human health.

Recent studies by NOAA, the FDEP and the Tampa Bay NEP provide the most complete assessment to date of toxic substances of concern and their distribution in Tampa Bay.[16] Contamination appears to be centered around large urban centers, ports and marinas, and concentrations generally diminish from the top of the bay toward the Gulf.

Results of a recent risk assessment conducted for the Tampa Bay NEP indicate that some contaminants are present at concentrations high enough to be harmful to fish and wildlife, either through direct exposure to bay sediments or indirectly through the food web. The first phase of the study, completed in 1996, assessed the risk to human health and marine life from contaminants in Hillsborough Bay and Boca Ciega Bay, two of Tampa Bay's most impacted sectors.[17]

The primary contaminants of concern identified in the study include metals, PAHs, PCBs, and chlorinated pesticides. Most of these pollutants enter the bay in stormwater runoff or through atmospheric deposition.

The second phase of the NEP risk assessment will focus on Bayboro Harbor and the western edge of Old Tampa Bay near Allen's Creek. These investigations will help identify which pollutants pose a continuing threat to the bay and those that represent past or inactive sources of pollution. Findings from the studies will be used to develop a more specific action plan addressing toxic contamination in 1997.

Although levels of most contaminants documented locally pose no known risk to humans, effects of repeated exposure to small amounts of these materials remain largely unknown. Some contaminated sediments remain inert or inactive for many years, then are disturbed by dredging, shipping, storms or animal activity. Bottom-dwellers that filter contaminated sediments — and the fish, birds and humans that ultimately consume them — can be placed at risk, since some toxic substances increase in concentration as they ascend the food web.

Toxics of Concern for Tampa Bay

	Contaminant/Impacts	Sources
Heavy Metals	**Cadmium** - Potentially toxic and may concentrate in food webs as it is retained for long periods in biological systems. Does not appear to accumulate in fish or undergo biomagnification, but does accumulate in sediments. High levels of cadmium present in sediments from the Hillsborough Bay/Lower Palm River, Allen's Creek, Cross Bayou and Boca Ciega Bay.	Common trace element widely employed in electroplating applications. Also present in paints, plastics, batteries and domestic sewage sludge.
Heavy Metals	**Chromium** - Exhibits varied levels of toxicity in different fish species. Also listed as a mammalian carcinogen. Highest levels in bay sediments found in Hillsborough Bay near the mouth of the Alafia River, in Boca Ciega Bay near Cross Bayou, and near Bayboro Harbor.	Atmospheric sources include alloy and metal production, coal combustion, waste incineration, cement production. Direct sources include electroplating/metal finishing, wastewater treatment plants, iron/steel foundries and other industrial applications, residential runoff and phosphate fertilizers.
Heavy Metals	**Copper** - Widely distributed in the natural environment, but also demonstrates acute toxicological effects at small concentrations above essential levels. Exceedingly toxic to aquatic biota. Highest levels in bay sediments found in Boca Ciega Bay near Cross Bayou, in Hillsborough Bay near the Alafia River and Davis Islands, and in Middle Tampa Bay near Bayboro Harbor and Papys Bayou.	Large number of human-induced sources to marine environment, including oil and fuel combustion, antifouling paints, metal-cleaning operations, plating baths and rinses, commercial pigments and dyes, wood preservatives, leachate from copper pipes, domestic sewage sludge, and copper sulfate used to control algae in reservoirs.
Heavy Metals	**Lead** - Causes a number of acute and chronic human health impacts, and accumulates in sediments. High levels found in bay sediments from Hillsborough Bay near the Alafia River, the lower Hillsborough River, and Boca Ciega Bay near Cross Bayou.	Largest source of lead to the environment originates from its past use as a gasoline additive and from atmospheric deposition from auto emissions. Paint, batteries and domestic sewage sludge also are potential sources.
Heavy Metals	**Mercury** - Naturally occurring in the environment, but also bioaccumulates in biota, causing acute toxicity at high concentrations. Sublethal effects include behavioral changes in invertebrates and birds, growth reduction in fish and algae, and impairment of senses and physical and mental development of children.	Atmospheric sources include municipal waste incinerators, fossil fuel combustion, paint additives (restricted by 1992), and re-emission from land sources. Used to produce batteries, electric switches and other electronic devices. Moves in sediments and water, and through bio-transportation.
Heavy Metals	**Zinc** - Toxic at high concentrations and widespread in the environment. Highest levels in bay sediments found in Boca Ciega Bay near Cross Bayou and in Hillsborough Bay near the Alafia River.	Major application is coating of other metals to protect against corrosion. Used widely as a component in batteries and tires. Sources include municipal wastewater and sludge, direct industrial discharges, surface runoff, and atmospheric deposition.
Pesticides	**DDT** - Animal and potential human carcinogen; biomagnifies in organisms and persists in the environment. Caused widespread contamination of fish and wildlife, especially during 1960-80. Banned in 1972. DDT remains in sediments at several bay sites. Highest concentrations are reported at northern Boca Ciega Bay, northern Hillsborough Bay and near the Alafia River and Papys Bayou.	Formerly used to control a broad spectrum of agricultural, silvicultural and household insect pests.

Figure 7

	Contaminant/Impacts	Sources
Pesticides	**Chlordane** - Environmentally persistent insecticide used extensively in termite control and also to control certain agricultural insects. Banned in 1988. Concentrations of chlordane at northern Boca Ciega Bay, Papys Bayou, Mullet Key and northern Hillsborough Bay were the highest of any sites measured in the bay.	Farmers used granular chlordane mixed with fertilizers for broad-spectrum insect control on fields. Also applied occasionally as a liquid spray for some beetles, and on golf courses. Agricultural and urban runoff are among the major documented sources.
	Mirex - Neuro-toxic pesticide; also known as Dechlorane. Sublethal effects in the marine environment include decreased algal growth, reduced fish growth, disrupted blue crab behavior, reduction in body weight and body lipid in salmon. Sublethal effects in birds include reduced reproductive capacity. Causes tumors in rats and mice. Mammalian symptoms include weight loss, enlarged livers, altered liver enzyme response, reproductive failure, fetal abnormalities including cataracts, heart defects, scoliosis and cleft palate. Concentrations of mirex in oysters from Tampa Bay are relatively high compared to many other sites around the nation. Production of mirex discontinued in 1977. Highest concentrations in bay sediments at Boca Ciega Bay, Mullet Key and Cockroach Bay.	Widely applied by aircraft to control fire ants on pastures between 1965 and 1978. Also used as fire retardant in electrical components, fabrics and plastics. Sewage sludge also a potential source.
	Endosulfan - Hazardous neuro-toxic pesticide with acute toxicity to marine organisms, high bioconcentration factor and fairly long half-life. Although not widely sampled for in Tampa Bay, endosulfan has been recorded in sediments from Cockroach Bay and in stormwater from an industrial park in West Tampa.	Introduced about 30 years ago and widely used to control winged insects associated with many row and field crops. Applied as a liquid spray to crops.
	Dieldrin - Pesticide for soil-dwelling insects including termites. Sublethal effects include starvation, liver damage, immunological suppression, decreased fertility, postnatal mortality. A carcinogen for some animals and a mutagen in cell cultures. Highest levels in bay sediments reported at the mouths of the Hillsborough River and Boca Ciega Bay.	Widely used from 1950-1974 to control soil insects on cotton, corn and citrus. All uses banned in 1985 except subsurface termite control and some mothproofing. Dieldrin is a breakdown product of the pesticide aldrin, both of which are long-lasting in soils and not highly water-soluble.
PCBs/PAHs	**PCBs** - Among the most persistent and toxic of organic compounds. Most risk of cancer from consumption of contaminated seafood attributed to PCBs. Biomagnifies. Manufacture ended in 1976. PCBs at sites in Hillsborough Bay exceed Florida's Probable Effects Level (PEL) for biological effects from toxic contaminants. PCBs also found in sediments at Boca Ciega Bay near Cross Bayou.	Formerly employed in a wide variety of industrial applications including insulation in electrical capacitors and transformers; paints, additives, adhesives, and caulking compounds; hydraulic fluids. Sources to environment are varied including direct discharge from production facilities into municipal sewage systems, leaching from disposal sites, refuse incineration and reuse of transformer oil.
	PAHs - Many PAHs are potent carcinogens or mutagens. Highest levels in bay sediments found in Hillsborough Bay near Davis Islands and the Alafia River, Boca Ciega Bay, and Middle Tampa Bay near Papys Bayou.	A group of related compounds present in crude oil and its products, released to the atmosphere during combustion. Also released from burning of non-petroleum substances, such as wood (brush fires). Sources include treated sewage, stormwater runoff and oil spills. Suspected sources include aerial fallout, petroleum refinery wastes, and discharges of drilling fluids.

pesticides. Agricultural runoff from pastures and rangelands, which cover roughly 28 percent of the watershed, account for another 13 percent of total bay nitrogen loadings. Forests and wetlands (at 7 percent) and mining (at 4 percent) comprise the remainder of nitrogen loadings in stormwater runoff.[23]

ATMOSPHERIC DEPOSITION

Coastal waters of the United States receive large quantities of nutrients, heavy metals and chemicals from the air — and Tampa Bay is no exception. Until recently, atmospheric deposition (pollutants carried in rainfall and dryfall, which consist of small particles and aerosols) had not been identified as a significant problem for Tampa Bay. Studies now suggest that about 29 percent of the bay's total nitrogen loadings are from atmospheric pollutants falling directly on the water.[24]

Nitrogen loadings from atmospheric deposition are actually much higher when pollutants falling in the watershed are included, since many of these will eventually enter the bay in stormwater runoff. About 1,100 tons of nitrogen is estimated to fall on the open bay each year in rainfall and dryfall. Another 6,600 tons fall in the watershed, although experts can't say how much of that reaches the bay. EPA estimates that as much as 67 percent of the bay's total nitrogen load could come from the atmosphere.[25]

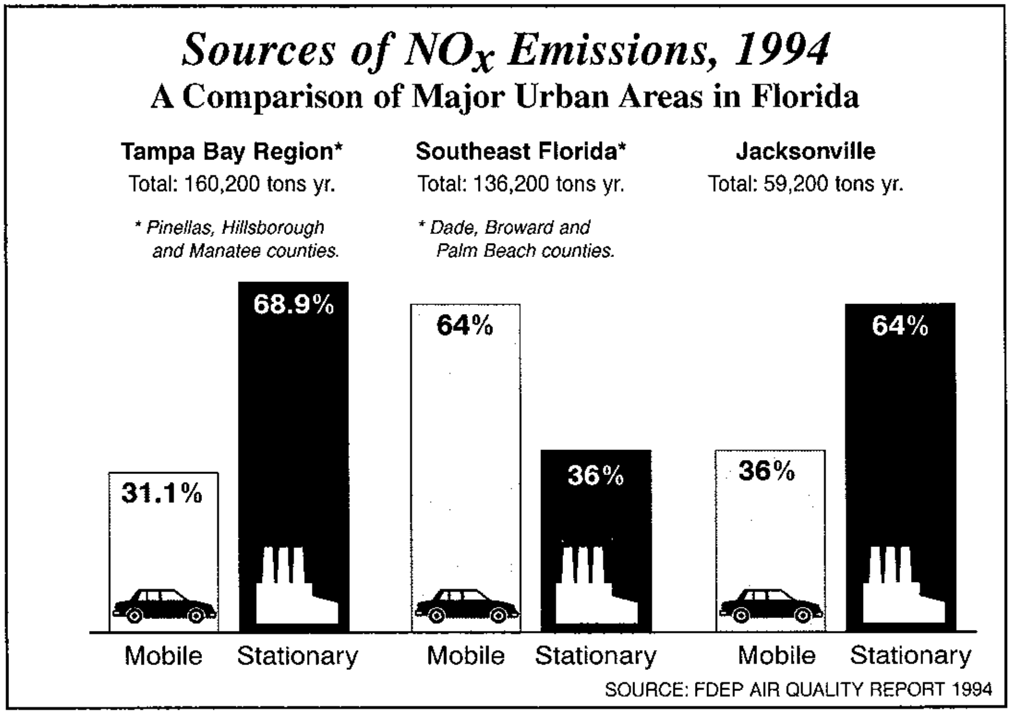
Several forms of nitrogen are contained in rainfall and dryfall to Tampa Bay. Nitrogen oxides (NOx) — mostly linked to power plant and vehicle emissions — are chemically transformed in the air, eventually returning to earth in aerosol or dissolved forms, such as nitric acid and other soluble nitrates in rainfall. Combined emissions from motor vehicles and power plants contributed almost 70 percent of the total nitrogen oxides that fell to the earth in the United States in 1984. Industrial sources provided another 15 percent.[26]

In the Tampa Bay region, stationary sources (primarily power plants) contribute an estimated 70 percent of the manmade NOx emissions as compared to 30 percent from motor vehicles.[27] One utility, Tampa Electric Company — which operates two coal-fired power plants on the bay — is the single largest source of NOx emissions in the region. According to the EPC of Hillsborough County, these two facilities emitted approximately 90,000 tons of NOx in 1994, representing nearly two-thirds of the total NOx emissions for Hillsborough and Pinellas counties.[28]

However, researchers can't say how much of what is emitted locally stays in the region or what percentage of emissions from outside the region are deposited here, since airborne contaminants may travel hundreds (or even thousands) of miles before settling to Earth. They also can't pinpoint what portion of nitrogen loadings from the atmosphere comes from natural sources, such as lightning. Additional research on natural and manmade sources and the relative contributions from local and distant sources is needed to effectively manage atmospheric deposition in Tampa Bay, which is expected to increase as population, power consumption and motor vehicle traffic grow.[29]

Between 1995 and the year 2010, nitrogen loadings to the bay from all sources are expected to increase by about 7 percent, or 17 tons per year.[30] But those estimates do not include changes that could occur as a result of new and unforeseen industrial discharges to the bay, or increased power generation at local utilities. Florida Power & Light (FP&L) Company's request to burn the controversial new fuel called Orimulsion,

Sources of Nitrogen Oxide **Figure 8**



Emissions data presented includes major stationary sources and "on-road" mobile sources, excluding other mobile sources such as boats.

for example, would have resulted in increased activity at its Manatee County plant. That increase in power generation would have resulted in an additional 20 tons of nitrogen loadings to the bay each year, according to the company. FP&L's request to burn the fuel was denied in April 1996 by the Governor and Cabinet in a 4-3 vote. The decision is now being appealed.

Toxic substances also enter the bay from the atmosphere in large quantities. For example, studies estimate that 44 percent of the bay's total cadmium loading, and about one-sixth of its copper and lead loadings, come from the air.[31] PAHs also enter the bay from the atmosphere, although loadings and specific sources are unknown. PAHs are associated with fossil fuel combustion, such as power plant and motor vehicle emissions and waste incineration.

WASTEWATER

While advances in wastewater treatment and increased regulation have helped reduce pollution, permitted sewage treatment plants and industries discharging directly to the bay ("point" sources) still contribute substantial pollutants to Tampa Bay.

Municipal sewage treatment plants in the watershed contribute about 10 percent (or 360 tons) of the bay's total annual nitrogen loadings.[32] Although all sewage treatment plants with surface discharge to the bay or its tributaries now provide Advanced Wastewater Treatment, roughly 36 billion gallons of effluent are still discharged to the bay each year, with Hillsborough Bay receiving the largest portion. In 1991, this bay segment received two-thirds of the cumulative nitrogen load from domestic wastewater treatment plants discharging to the bay.[33]

Wastewater discharged from industrial facilities in the Tampa Bay watershed is responsible for about 4 percent of total nitrogen loadings.[34] Fertilizer manufacturing and shipping facilities are the largest industrial point sources.

Industrial and municipal point sources also are a major pathway for toxic substances, contributing roughly 30 percent of the bay's total loadings of arsenic, cadmium, chromium and copper, as well as low levels of other contaminants.[35] Residents also can contribute to the problem by pouring down drainpipes toxic cleaners or solvents that local sewage treatment plants cannot completely remove.

OTHER SOURCES

Septic tanks, which are estimated to serve about 20 percent of the watershed's populace, also are a key part of the pollution puzzle in localized sectors of Tampa Bay. Preliminary studies conducted for the Southwest Florida Water Management District (SWFWMD) suggest that nitrogen loadings from septic systems, as well as septic waste and sewage treatment sludge, contribute as much as 4 percent to the bay's overall nitrogen loadings.[36] Older septic systems located near the bay pose a particular threat to water quality, since most are not designed for nitrogen removal.

Disposal of sewage sludge poses a special problem, particularly in the Hillsborough and Manatee river basins, because of the number of permitted disposal sites. Different agencies regulate disposal sites and it is difficult to determine how much material is being spread and how it is handled. Additionally, some of the sludge disposed of in the Tampa Bay watershed actually comes from outside the region.[37]

High densities of mostly older septic tanks can contribute to degraded water quality (nutrients and pathogens) in creeks where circulation is limited and the water table is near the ground surface. Pinellas County's Allen's Creek and several creeks in Hillsborough County are among those thought to be at risk.[38] Septic systems along tributaries leading to Tampa's McKay Bay also are believed to be a problem.[39] Springs that feed into the bay's rivers and smaller tributaries also may be impacted by septic tank leachate, especially in areas with very porous soils.[40]

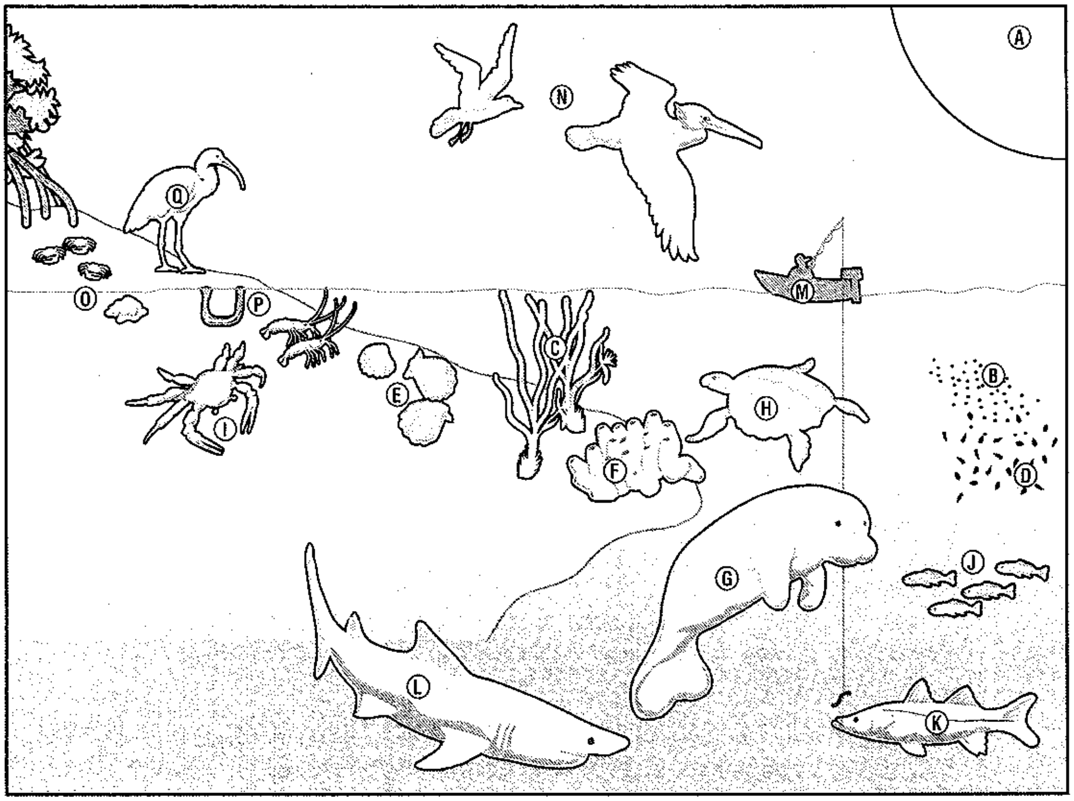
Preliminary estimates developed for the NEP suggest that ground water and springs contribute about 5 percent of the bay's total nitrogen loadings.[41] Nitrogen (particularly nitrate) concentrations in springs in the area appears to be increasing, possibly due to changes in land use in the spring recharge areas.[42]

Another 7 percent of the bay's total nitrogen loadings is attributed to fertilizer lost during shiploading and landside on route to port.[43] However, the amount has declined substantially since 1991 as a result of efforts to improve portside facilities.

BAY HABITATS

While many bay animals prefer the open water of the estuary, others require the food and shelter supplied by various structural habitats, including seagrasses, mangroves, salt marshes and uplands. Together, these habitats form a natural network that sustains vast populations of fish, birds and other wildlife.

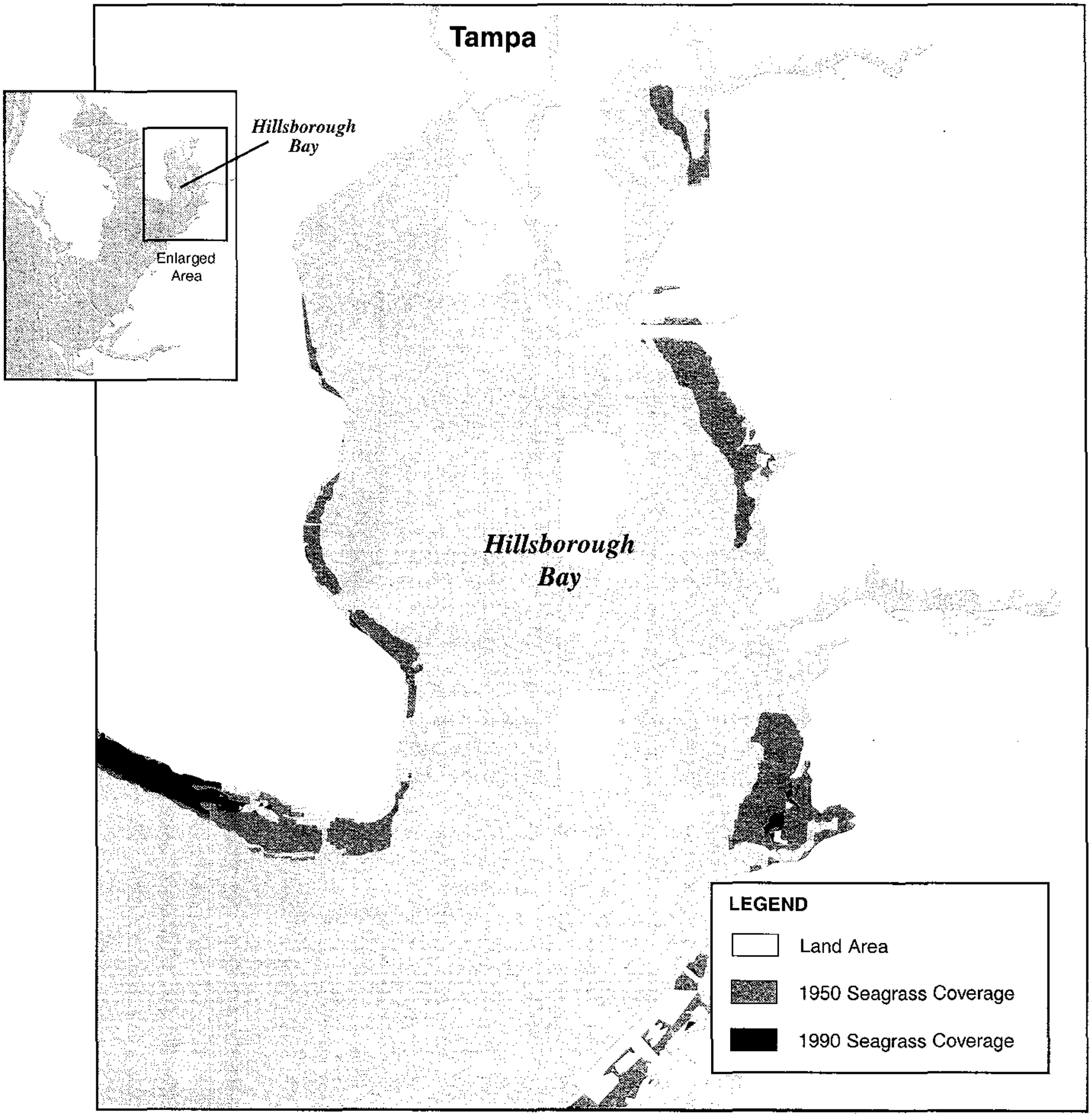
Tampa Bay Food Web **Figure 9**



Tampa Bay's food web provides a "who eats who" perspective of the ecosystem. But in reality, it is far more complex. The marine food web, as its name implies, travels in various directions, bound together by common, interdependent threads. Impacts to any part of the food web affect the health of the whole.

- The bay's food web begins with sunlight[A], which penetrates through the water column.
- The sun's energy is absorbed by tiny one-celled organisms called phytoplankton[B], microscopic algae that are the most prolific of the bay's primary producers. Light also is absorbed by seagrasses[C] and other underwater plants. There are 270 species of phytoplankton in Tampa Bay, and a single quart of bay water may contain as many as 1 million of these minuscule creatures, which give the water its greenish cast. By comparison, the bay supports only four major seagrass species.
- Small grazing animals called zooplankton[D] and larger bottom-dwelling filter feeders form the next thread in the web. Filter feeders such as the bay scallop[E] and the sea squirt[F] are a prime cleaning service for the bay, siphoning in water containing phytoplankton, skimming off the tiny organisms, and discharging clear water. Larger herbivores, such as manatees[G] and green sea turtles[H], consume bigger plants like seagrasses.
- Carnivores and omnivores (opportunistic feeders that eat plants and animals) prey on the zooplankton and the filter feeders. Small carnivores such as the blue crab[I] and pinfish[J] are in turn eaten by larger carnivores such as snook[K], redfish and trout, which are eaten by sharks[L], dolphins and humans[M]. Some birds, such as pelicans[N] and cormorants, also eat the small fish and invertebrates.
- When plants and animals die, their remains sustain another thread in the web, the scavengers. Some of these, such as fiddler crabs[O] and snails, live in burrows along the shoreline. Others, like worms and shrimp[P], dwell in the muds at the bottom of the bay. The muds of the shore and bay bottom may look barren to a casual observer, but they teem with life.
- The scavengers begin another circle of life, providing food for a variety of shorebirds such as the white ibis[Q] and the roseate spoonbill, which frequent the bay's shallows. Small mammals such as raccoons also prey on crabs and snails.

1950 vs. 1990 Seagrass Coverage — Figure 11



Since 1950, pollution and dredging in the heavily industrialized Hillsborough Bay sector have claimed more than 90 percent (or 2,277 acres) of seagrasses. This compares to an overall seagrass loss in the bay of almost 40 percent (15,200 acres) for the 1950-1990 period. Recent improvements in water quality are beginning to reverse the course of seagrass declines. From 1982-1992, scientists have documented the return of more than 4,000 acres of seagrass baywide, including 20 acres in Hillsborough Bay. Seagrass coverage in Hillsborough Bay has more than doubled since then.

SOURCE: SWIM (1994) AND R. JOHANSSON (1995)

Seagrass transplanting also may be viable in some areas of the bay, although its success rate varies and it is still experimental. Pioneering efforts by scientists at the Florida Marine Research Institute (FMRI) show promise in laboratory cultivation of plant fragments for large-scale restorations.[53] And some local transplanting projects, such as the City of Tampa's in Hillsborough Bay, have been successful.[54] The NEP will evaluate suitable areas for transplanting projects as part of its overall seagrass recovery strategy.[55] Continued monitoring will be necessary to document the trends in seagrass regrowth.

Although more than 40 percent of seagrasses reveal little or no damage from boat propellers, seagrass scarring is nevertheless an important problem in some parts of the bay. Studies by the FMRI indicate that about 27 percent of Tampa Bay's seagrasses are moderately to heavily scarred — second in severity only to the Florida Keys.[56] Signs of chronic damage are evident around many passes and channels. Studies at Weedon Island Preserve suggest that propeller scars in turtle grass may take more than five years to heal.[57]

Intense scarring at Cockroach Bay in southern Hillsborough County and at Pinellas County's Ft. DeSoto Park has prompted boating restrictions and other measures in these areas to protect seagrasses.[58] Channel marking and education appear to be the most effective techniques for reducing damage to grass beds.[59]

The quality of the bay's seagrasses, and their utilization by animals, has not yet been fully evaluated. However, the SWFWMD recently modified its seagrass monitoring program to include assessments of seagrass quality at 60 locations around the bay. Monitoring parameters include seagrass species diversity, density and quantity of epiphytic algae attached to the grass blades, as well as physical parameters such as salinity, pH and water depth.[60]

SOFT-BOTTOM

More than 80 percent of the bay bottom is sand or mud, although the term "soft bottom" can be misleading since a large part of the bay floor is actually hard-packed sand and shell.[61] These bottom sediments support a large variety of organisms, including parchment worms, clams, tunicates (or sea squirts) and conchs. The surface sediments of this dynamic habitat are periodically churned up and re-deposited by bottom-dwelling animals, as well as by waves, currents and dredging.[62] More than 500 types of macroinvertebrates baywide and an average of 10,000 organisms per square meter were documented in 1993 — the first year of benthic sampling conducted by the EPC of Hillsborough County and Manatee County for the Tampa Bay NEP.[63]

Dredging of navigation channels and underwater disposal of dredged material have impacted an estimated 14,400 acres of bay bottom, mostly in deep-water areas of the bay. An additional 1,200 acres of deep-water soft bottom has been filled to create spoil islands and causeways.[64]

The long-term effects of disposal on these soft-bottom habitats has not been well documented. However, the benthic monitoring program established in 1993 by NEP and the bay's three surrounding counties will eventually enable scientists to assess trends in the quality of these bottom communities. Samples are taken each year during the critical monitoring period (September and October) at more than 100 stations, and

Mangroves and marshes also support juvenile fish, such as snook, tarpon, red drum and mullet, and protect them from larger predators. Mature mangroves in quiet lagoons and canals in fairly high-salinity areas provide an important nursery habitat for snook.

Mangroves in Tampa Bay are particularly vulnerable to damage or destruction from periodic freezes, since the bay is near the northern limit for these species. This underscores the importance of maintaining a healthy abundance of these wetland habitats. Dense stands of mangroves not only are better equipped to survive a freeze, they also provide more food and better habitat for the animals they support.

Pruning of mangroves can affect their productivity. Public outcry against a 1995 law that made it easier for residents to trim mangroves prompted the Florida Legislature to revisit the issue in 1996. A new mangrove trimming bill was passed, reinstating some trimming restrictions and providing additional penalties for violators. State officials do not know how many acres of mangroves were trimmed during 1995, but say the damage was severe in many cases.

About 21 percent (5,128 acres) of Tampa Bay's original saltwater wetlands were destroyed between 1950 and 1990, primarily due to dredging and filling for waterfront development. These losses were not distributed equally among bay habitats, with the greatest declines documented for tidal marshes (38 percent), followed by salt barrens (36 percent) and mangroves (13 percent).[70]

The steepest declines occurred during the 1950s and 1960s, when efforts to develop coveted waterfront property for residential and commercial uses proceeded unchecked. The passage of wetlands protection laws during the mid-1970s and 1980s has greatly slowed the rate of loss, and studies indicate a slight increase in tidal wetland coverage since 1982, due to recent habitat restoration efforts and natural colonization of marshes and mangroves along causeways and other filled lands.[71]

Recent estimates of wetland habitat in Tampa Bay indicate that about 18,800 acres of mangrove forests and salt marshes remain.[72] However, thousands of acres of these native habitats have been displaced by invasive exotic plants, such as the Australian pine and Brazilian pepper.

MUD FLATS AND SALT BARRENS

Mud and sand flats along the bay's perimeter also are an important part of the estuarine wetland system. While these largely non-vegetated areas may appear barren and lifeless to an untrained eye, they are highly productive and valuable.

On closer inspection, so-called "non-vegetated" shallow bottom areas more closely resemble a secret garden teeming with microscopic plant life. Invisible to the untrained eye, single-celled algae and bacteria proliferate here, giving the bay floor a subtle brown or greenish cast. What's more, these diminutive residents pack a sizeable punch as fuel for the bay's primary productivity. Indeed, in shallower ecosystems, the sheer number of these bottom-dwelling organisms often exceeds the amount of phytoplankton in overlying waters.[73]

Mud flats support a diverse community of bottom-burrowing creatures, including worms, clams and crabs, which are pursued by wading birds and raccoons foraging for food at low tide. At high tide, fish enter the flats in search of food.

These areas also are prime feeding areas for a number of migratory birds, including ducks, gulls, avocets and several species of sandpiper, which seek refuge in Tampa Bay each winter.

Fewer than 900 acres of salt barren remain, mostly along the bay's southeastern rim.[74] Historical estimates of this habitat are unavailable. Salt barrens forms in areas where brackish water moves in during very high tides and evaporates, creating open stretches of salty, dry soil. This hyper-saline terrain supports low-growing succulent plants and serves as a seasonal feeding habitat for wading birds.

ASSOCIATED UPLANDS

Neighboring upland habitats of pine forests, hammocks and shrubs also have been heavily impacted by development. Often overlooked or undervalued, these buffer areas and associated freshwater wetlands provide important habitat for numerous animals, including the wood stork, white ibis, osprey, bald eagle and Sherman's fox squirrel. Many of the birds and animals that live in coastal wetlands or along the shore hunt for food in upland forests and fields. Likewise, many upland species depend on adjacent wetlands for survival.

Almost all coastal pine forests, which are critical nesting sites for bald eagles, have been eliminated from the shores of Tampa Bay, and about 40 percent of this habitat has been lost throughout the watershed.[75] Coastal hammocks also have declined. Coastal hammocks of live oaks and cabbage palms occur in patches where wetlands transition to uplands, and are home to raccoons, bobcats, foxes and other animals that feed in neighboring wetlands.

LOW-SALINITY HABITATS

The bay's four major rivers — the Hillsborough, Alafia, Manatee and Little Manatee — and more than 100 smaller tributaries provide critical low- and medium-salinity habitat for numerous species of fish and shellfish at early stages in their development. Variations in the salt content of the water, from the low-salinity reaches of the bay's tributaries to full-strength sea water at the mouth of the bay, determine which areas of the estuary are inhabitable for some species and not for others. Oysters, for example, flourish in low-salinity areas of the bay where they are protected from snail predators. Similarly, fish with wide salinity tolerances use low-salinity areas in rivers to avoid predators that cannot tolerate these conditions.

Called oligohaline from the Greek oligos (small) and haline (salty), the low-salinity areas occur in the upper reaches of the bay's tributaries, where salinities range from zero to 10 parts per thousand (ppt), as compared to about 35 ppt at the mouth of Tampa Bay. Downstream, mesohaline or medium-salinity zones occur within a salinity range of 11 to 19 ppt.

Low and medium-salinity habitats are a primary nursery for red drum, snook and tarpon, as well as numerous non-game species such as the striped mullet. Some of the most highly productive juvenile nursery habitat occurs where these low-salinity waters overlap with shoreline or submerged vegetation. As the fish mature, they typically move to more saline zones in the estuary or out into the Gulf of Mexico.[76]

Efforts to protect these highly productive nursery habitats depend on maintaining the proper timing and flows of fresh water and salt water within the bay's tributaries. Four major tributaries — the Hillsborough River, Palm River (Tampa Bypass Canal), Manatee River and Braden River — have dams or reservoirs that divert fresh water to serve the region's drinking water and irrigation needs. During dry season, when water demand is highest, reservoirs on the Hillsborough, Palm and Manatee rivers release almost no water downstream.

Local water supply development plans may further reduce the flow of fresh water into already impacted tributaries and bay segments. For example, the Tampa Water Resource Recovery Project would remove up to 50 million gallons per day (mgd) of fresh water currently discharged to Hillsborough Bay from the City of Tampa's sewage treatment plant, and possibly reduce flows to the Tampa Bypass Canal and McKay Bay. However, the project also will remove a major source of excess nitrogen to the bay. An environmental impacts assessment will be conducted as part of this project.[77]

Additionally, the West Coast Regional Water Supply Authority proposes to remove 7 mgd from the Alafia River during the first phase of its 1995 Water Resource Development Plan (1995-2000).[78]

The impact of reservoirs on the low and medium-salinity habitats downstream is the subject of several ongoing assessments. One study of flow variations on the Manatee River indicates that, on average, river area and volume within the low-salinity band were reduced 33 percent and 22 percent, respectively, as a result of reservoir operations for the period 1982-1992. Consequently, the area of wetlands coinciding with this low-salinity band was reduced by 150 acres, or 25 percent.[79]

Modeling comparisons of historic and modern landscapes indicate that net freshwater inflows to the main body of Tampa Bay have changed little since the 1950s, assuming the same amount of rainfall each year.[80] This is mainly a result of increases in urban and agricultural stormwater runoff, which have countered decreases in freshwater flows from rivers. However, long-term measurements of river flows by the U.S. Geological Survey indicate that some rivers in southwest Florida (including the Hillsborough River) have experienced gradual freshwater declines since the 1930s, partly because of declining rainfall.[81]

Fish and Wildlife

FISHERIES

The populations of many sport and commercial fish species in Tampa Bay are in a state of flux. Anecdotal reports from sport fishermen indicate some species such as snook and red drum are responding positively to fishing regulations designed to increase their numbers. On the other hand, commercial landings of black (or striped) mullet and spotted seatrout are significantly below historical catches.

A constitutional ban on gill netting, triggered in part by declining mullet stocks, took effect in July 1995. Supporters believe the ban will lead to increases in mullet populations, which are fished almost exclusively by commercial netters. The ban also may benefit other species like spotted seatrout and sheepshead, targeted by both commercial and recreational fishermen.

Bait fish such as menhaden and herring also were targeted for increased protection following precipitous declines in bait fish landings in the late 1980s. The 1993 ban on purse seining in the bay is expected to stabilize bait fish populations, as well as benefit other fish and birds that feed on the bait fish.

Careful monitoring of fish populations will be necessary to gauge the effectiveness of these existing regulations and determine the need for further management actions.

Until recently, resource managers have had to estimate populations of important fishery species in Tampa Bay from landings data because direct measurements were not available. These data, which record the amounts and types of fish brought to Pinellas and Hillsborough docks by area fishermen, indicate that 3.7 million pounds of 11 commercial species of finfish were harvested from the bay in 1990 — a decrease of 24 percent since 1966. The decrease is largely due to reduced catches of mullet and sea trout, while landings for the remaining species stayed the same or increased slightly.[82]

However, records going further back, to 1950, show that harvests of spotted sea trout declined 86 percent in the bay by 1990, from 487,000 pounds to 67,000 pounds. Similarly, red drum harvests plummeted from 80,000 pounds in 1950 to 15,000 pounds in 1986, the last full year of available data prior to a statewide ban on commercial red drum harvests.[83] These raw data do not reflect changes in fishery management plans or quotas.

Prior to the net ban, mullet was the most sought-after commercial species in the bay, comprising almost half of the 1992 landings of finfish and shellfish, or 2.3 million pounds. By comparison, bay harvests of spotted seatrout and bait shrimp were only 40,000 pounds and 26,000 pounds, respectively.[84]

Although useful, landings can be a misleading indicator of population stocks because natural fluctuations and changes in market demand, gear efficiency and fishing regulations may affect them. Additionally, commercial landings are often under-reported and tend to decline as recreational fishing increases. Recognizing this, the FMRI in 1989 initiated a Critical Fisheries Monitoring Program (CFMP) to provide more reliable estimates of stock sizes and distribution of important species and key prey species. The research also is helping clarify the crucial role habitat plays in the life cycles of many species.

A summary of results of the first three years of the CFMP (1989-1991) found that 78 percent of the juvenile spotted seatrout collected were captured over seagrass beds, further validating the importance of seagrass habitat to this species. Small red drum were found in relative abundance in the bay's major tributaries, while small snook are known to frequent at least two of the rivers, the Alafia and Little Manatee.[85]

Mirroring declines in fish stocks, Tampa Bay's once-thriving commercial shellfish industry also has virtually collapsed, although bait shrimping and some food shrimping continues. Harvests of clams and oysters throughout the bay are restricted or prohibited because of documented or potential bacterial contamination from fecal coliform associated with human and animal wastes entering the bay in stormwater runoff. In the few unrestricted areas remaining, shellfish populations are not large enough to support commercial harvest.

However, reassessments of closed or restricted areas are not routinely performed by the state, and it is possible that actual water quality conditions in specific areas do not warrant the restrictions. That's because decisions to classify or reclassify areas in most cases are based on land use considerations and the documentation of or potential for contamination following a major storm event, rather than actual water quality conditions.[86]

The bay's fisheries also are impacted by entrainment, the capture of planktonic eggs and larvae of fish and shellfish in power plant cooling intakes. The five power plants around Tampa Bay take in a daily average of about 2.3 billion gallons of bay water. An estimated 274 billion fish eggs and 83 billion fish larvae are captured annually in cooling intakes in Tampa Bay, according to power plant monitoring data from the early 1980s.[87]

Assuming 100 percent mortality, the impact of steam electric plants on the fishery stocks of Tampa Bay may be significant. However, in the absence of sufficient baseline data on stock sizes and normal survival rates, it is difficult to fully assess this impact. Further evaluation is needed to understand the cumulative impacts of power plant entrainment on the bay's fisheries.

Habitat declines, water quality and fishing impacts are considered the primary factors responsible for changes in fish populations. The relative impact of each factor is often hard to discern because of natural fluctuations in stock sizes.

Despite these pressures, improving water quality and restoration of habitats throughout Tampa Bay are creating more favorable conditions for fish and shellfish and for the seagrass habitats they require. One potential beneficiary is the bay scallop, which all but disappeared from Tampa Bay in the 1960s. While experts can't say why the scallop departed decades ago, they suspect these highly sensitive creatures were casualties of pollution. Water quality in Tampa Bay now has improved to levels that may support scallop recovery,[88] and some restocking efforts have been undertaken.[89]

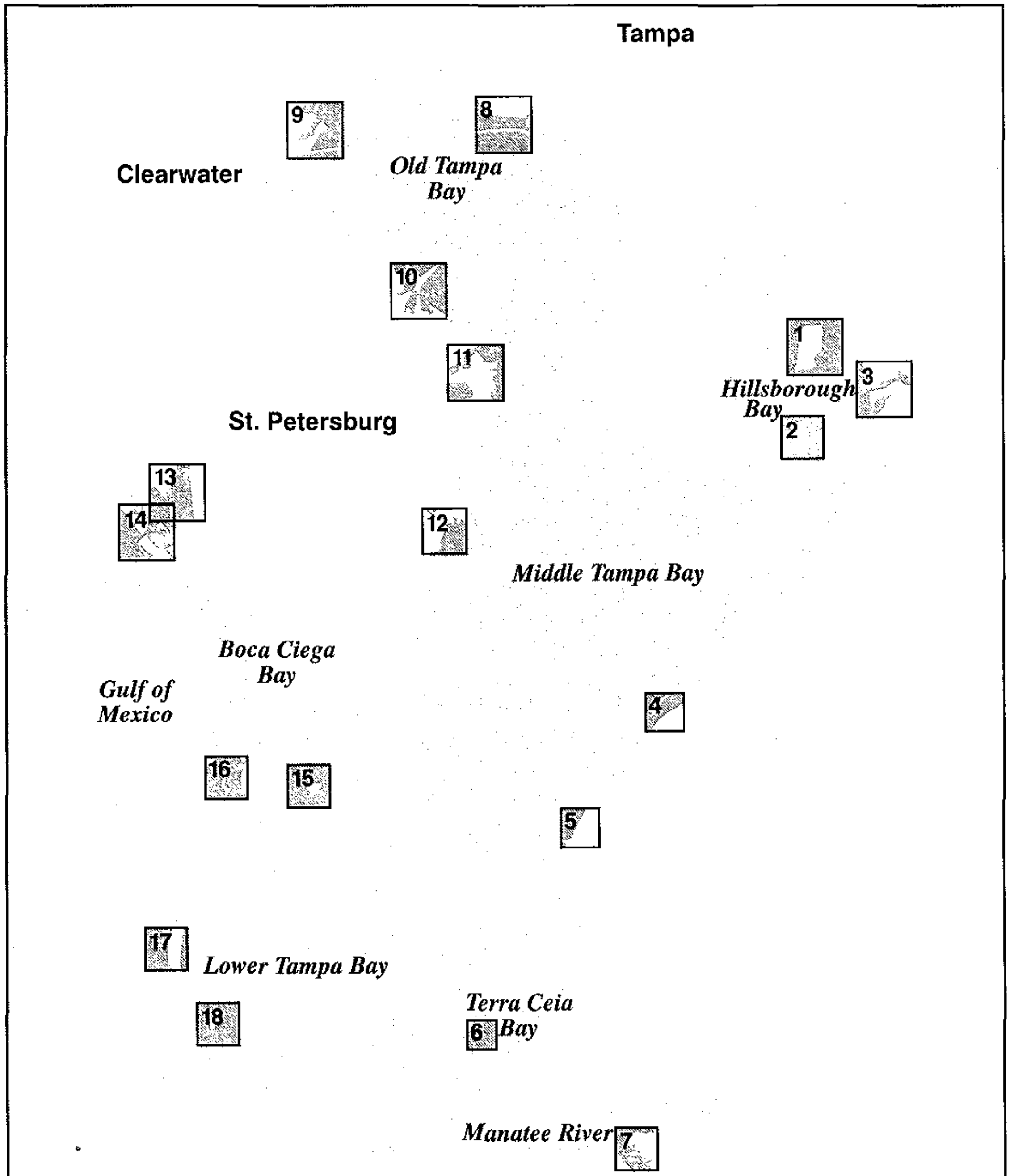
Mortality for scallops transplanted in the bay was unacceptably high in 1995, according to a 1996 report from the FMRI for the Tampa Bay NEP. Researchers say red tide — a common Gulf coast nemesis — is likely to blame. FMRI believes that bay scallops can be successfully cultured and reintroduced to Tampa Bay, but recommends selecting a variety of transplant sites within the lower bay to minimize exposure and localized impacts.[90]

BAY WILDLIFE

Tampa Bay supports a magnificent array of wildlife, from the familiar brown pelican to the bottom-hugging sea squirt. But many of these animals also are threatened by impacts to water quality and habitats.

Birds are perhaps the most easily recognized and appreciated creatures in the ecosystem, and mangrove islands in the bay are among the most important nesting sites in

Important Bird Nesting Colonies of Tampa Bay — Figure 13



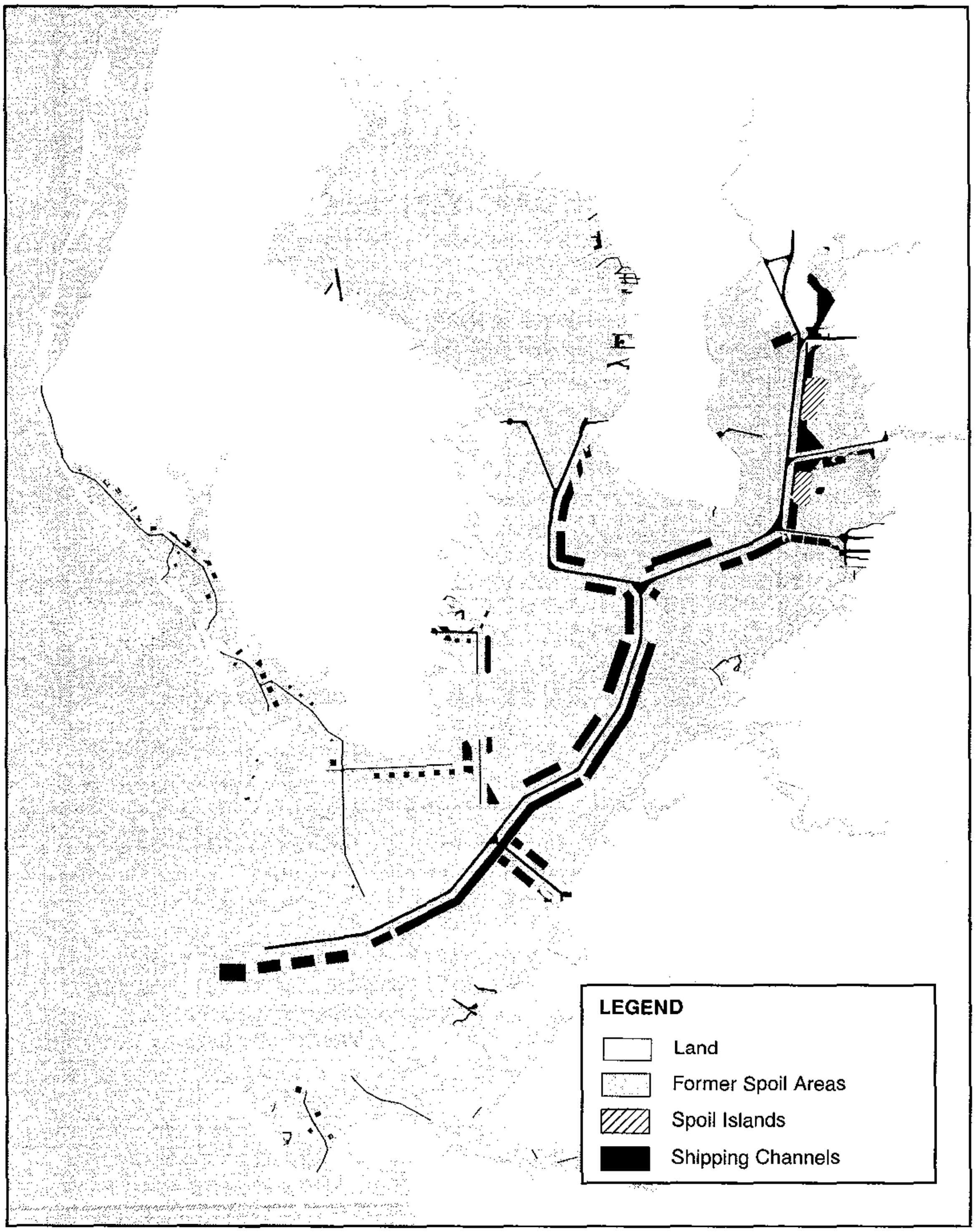
LEGEND

1. Island 2D (Tampa Port Authority)
2. Island 3D (Tampa Port Authority)
3. Alafia Banks*
4. Cockroach Bay Shell Pit
5. Piney Point
6. Washburn Sanctuary* (Terra Ceia Bird Key)*
7. Dot-Dash (mouth of Braden River)
8. Courtney Campbell Causeway
9. Alligator Lake
10. Howard Frankland Causeway
11. Florida Power Rooftop/Weedon Island
12. Coffee Pot Bayou
13. Dogleg Key
14. John's Pass
15. Tarpon Key**
16. Shell Key
17. Egmont Key
18. Passage Key**

* National Audubon Sanctuary
**National Wildlife Refuge

SOURCE: NATIONAL AUDUBON SOCIETY, TAMPA BAY SANCTUARIES

Tampa Bay Shipping Channels and Spoil Areas **Figure 14**



SOURCE: COASTAL ENVIRONMENTAL, INC.

Effective long-term planning and coordination among ports, the U.S. Army Corps of Engineers, and environmental and business interests is needed to explore long-term disposal options, including beneficial uses of spoil material, and to minimize the ecological impacts of dredging.

Spill Prevention and Response

More than 4 billion gallons of oil and other hazardous materials pass through Tampa Bay each year on large vessels that must navigate relatively narrow channels. Another 18 million tons of refined fertilizer products and phosphate rock are exported from the bay area annually.[103] Sulfuric acid and anhydrous ammonia, used in the processing of fertilizer, routinely traverse the bay en route to fertilizer processing facilities.

While this bustling nautical highway brings billions of dollars in economic rewards to the region, it also poses an environmental risk to the bay and underscores the need for effective spill prevention and response.

That risk was brought home to area residents in dramatic fashion in August 1993, when two barges and a freighter collided near the mouth of the bay in a fiery collision that resulted in a spill of nearly 330,000 gallons of oil.[104] Winds and tides pushed most oil offshore, and the quick response of federal, state and local agencies and the maritime industry helped to spare the bay serious damage. Still, oil coated numerous seabirds, fouled area beaches and blanketed small mangrove islands in the Intracoastal Waterway, with cleanup costs borne by industry and government exceeding $100 million.[105]

Cooperative efforts led by the U.S. Coast Guard (USCG), Florida Department of Environmental Protection and Tampa Bay Regional Planning Council have been lauded for providing critical advance planning and response for such accidents. Local governments, shipping interests and utilities are also a part of this local advance planning network. However, the spill pointed out several important equipment, planning and navigational needs that could help avoid similar tragedies in the future. In particular, officials have pledged renewed efforts to focus on ways to prevent spills from occurring.

Public concerns about the impacts of oil spills on the bay were heightened again when Florida Power & Light proposed to burn Orimulsion at its Manatee County plant. Because the thick, emulsified fossil fuel disperses in the water column rather than floating on top where it can be skimmed off, removal with current cleanup and containment technology would be nearly impossible.

Thanks to existing safety protocols, large spills have been relatively rare in Tampa Bay. In fact, small spills averaging 25 gallons or less constitute 95 percent of the 422 spills reported in the Tampa Bay region from April 1993 through September 1995.[107] Many more small spills go undetected. Efforts to address these smaller, chronic discharges are vitally important, since their cumulative impacts may be substantial.

Small spills occur frequently at dockside as boats are refueled. Oily bilge water also enters the bay from smaller craft when bilge pumps are discharged. Leakage and spills

Subsequent state legislation, through the Wilson-Grizzle and Grizzle-Figg initiatives, required all sewage treatment facilities discharging to the bay to meet advanced treatment standards.

The city of St. Petersburg chose another route to address its sewage disposal problems when it pioneered the first large-scale wastewater reuse program in the state, resulting in almost zero discharge to the bay. However, the city had problems during abnormal wet weather conditions with discharges into Boca Ciega Bay caused by unintentional sewer overflows during the late summer of 1995.

In the late 1960s, the Environmental Protection Commission (EPC) of Hillsborough County was established. Over the years, the EPC has provided a comprehensive record of long-term water quality record in the bay — critical for tracking and documenting the "bad old days" and the bay's progressive recovery. EPC was one of the first agencies to identify sewage treatment problems in the bay, and its wetlands protection rules are among the strictest in the state.

A decade later, the Hillsborough Environmental Coalition, a grass-roots citizens group, led efforts to fight environmental impacts associated with the Tampa Harbor Deepening Project. The Coalition supported Manatee County's legal actions against the federal government regarding the proposed dumping of dredged material from the project into the Gulf of Mexico. The group also worked to improve coordination of coastal land acquisition, efforts which would eventually lead to the establishment of Hillsborough County's Environmental Lands Acquisition and Protection Program (ELAPP). Efforts such as these reinforced the importance of bridging jurisdictional boundaries to effectively protect the Tampa Bay ecosystem.

Residents continued to exert pressure to clean up the bay, and that groundswell of support reached the state Legislature in the early 1980s. The Legislature established a bay study commission composed of elected officials and interested citizens to examine ways to improve bay protection. The study commission resulted in the formation in 1985 of an advisory group, the Agency on Bay Management (ABM). An arm of the Tampa Bay Regional Planning Council (TBRPC), the Agency has become a vigilant guardian of the bay. The 45-member coalition — which includes elected officials, regulators and representatives of special interest groups and local governments — has been successful in focusing public attention on bay problems and in bringing together diverse and often competing bay users.

The Legislature also established four Aquatic Preserves in the Tampa Bay watershed to protect remaining natural areas. Stricter permitting standards apply within the preserves, which encompass more than 370,000 acres of submerged lands in Hillsborough, Pinellas and Manatee counties.

Stormwater permitting for new development was initiated in the mid-1970s by the Florida Department of Environmental Protection (FDEP) and later delegated to the Southwest Florida Water Management District (SWFWMD). In 1984, SWFWMD adopted new rules for the management and storage of surface waters, launching a comprehensive surface water management program for new development which included permitting requirements for stormwater treatment as well as flood control.

In 1987, the Legislature created the Surface Water Improvement and Management (SWIM) program to restore and protect the state's most threatened waterways. At the urging of the ABM, Tampa Bay was named in the SWIM Act as a priority waterbody within SWFWMD. Since 1989, SWIM has created or restored more than 110 acres of estuarine and coastal habitats and provided stormwater treatment for more than 5,000 acres of urban lands in the bay watershed.

Despite the progress that has been made, many bay managers believe the bay still lacks a comprehensive and cohesive protection scheme. Thus, widespread support was given in 1990 to Tampa Bay's adoption into the National Estuary Program by EPA to assist the region in developing a comprehensive conservation and management plan for the bay.

A required step in that process is identifying where unnecessary duplication exists in current environmental programs to ensure that limited public funds are spent in the most effective manner.

BAY MANAGEMENT EXPENDITURES, OVERLAPS AND GAPS

Management of Tampa Bay is currently shared by dozens of federal, state, regional and local agencies and by different departments within those agencies. A short list includes the EPA, the U.S. Army Corps of Engineers, the FDEP, the TBRPC, the SWFWMD, and the Tampa Port Authority, which has been deeded all state-owned or sovereign bay bottom in Hillsborough County. On the local level, resource management is divided among county and city planning, stormwater, solid waste, wastewater, and environmental protection departments.

A 1994 survey conducted by the Tampa Bay NEP attempted to quantify how much money is spent to manage and monitor bay quality and administer environmental programs. That study, based on FY94-95 budgets, indicates that more than $250 million is spent annually by federal, state and local agencies and governments on the restoration and management of Tampa Bay.

By far, the largest portion of that figure — 68 percent or roughly $170 million — is attributed to wastewater collection, treatment and reuse, activities which directly or indirectly benefit the bay even if they aren't performed solely for the bay's benefit. The second largest allocation of about 14 percent or $35 million is expended primarily by local governments and the SWFWMD for stormwater management, including handling and treatment. Regulation and enforcement activities comprised 5 percent or $13.5 million of total expenditures. Habitat restoration, preservation and management totalled approximately $7 million or nearly 3 percent, excluding land acquisition expenditures (nearly 4 percent). Dredging and dredge material management, environmental monitoring and public education comprised the remainder of the expenditures (See Figure 15).

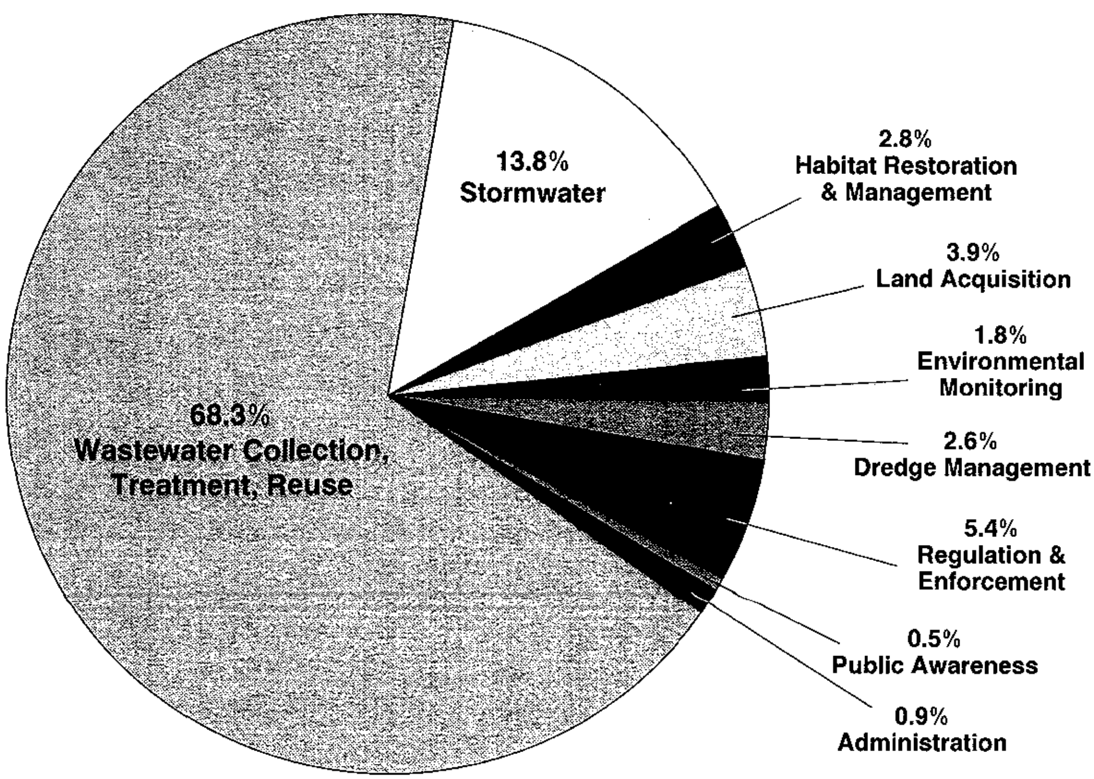
The bay's complex management system has led to duplications in some areas and gaps in others. Bay managers who responded to the NEP's 1994 survey generally agreed that duplications occur most frequently in permitting activities, while gaps are most evident in enforcement and monitoring programs. Bay managers also cited turf-guarding as a problem, and noted the lack of a comprehensive, readily available data base through which valuable information about the bay's health and living resources could be shared.

The permitting arena serves as an example of what some believe is unnecessary duplication of effort. An applicant seeking permission to remove or alter wetlands along the bay may have to obtain permits from as many as half a dozen agencies, depending on the extent of wetland impacts and the project's location.

That process was streamlined in October 1995 as a result of the state's new Environmental Resource Permit (ERP), which consolidated review of existing dredge-and-fill, stormwater management and sovereign lands permits into a single permit to be issued by either FDEP or the water management district, depending on the type of project.

SWFWMD now utilizes a "cradle-to-grave" system, in which one person oversees all facets of a given permit, from review and approval to compliance monitoring and

Bay Management and Related Expenditures Federal, State and Local (FY94-95) **Figure 15**



This chart illustrates how money spent on bay restoration and management is allocated by federal, state and local agencies and governments, based on FY94-95 expenditures of more than $250 million.

SOURCE: HAZEN AND SAWYER (1996), *FUNDING SOURCE INVENTORY FOR CCMP ACTION PLANS.* PREPARED FOR THE TAMPA BAY NATIONAL ESTUARY PROGRAM enforcement. This approach is highly efficient because it provides responsibility for all follow-up activities to the staff member most familiar with the project.

Inconsistencies also characterize the permitting process. Because communities have adopted individual wetlands rules based upon their residents' perceptions of important environmental concerns, an applicant's project could be denied by one agency and approved by another. If the project is approved, the applicant could be required to meet widely varying mitigation and monitoring requirements imposed by each regulatory agency.

Until recently, publicly financed restoration projects were further complicated by state agency requirements that they undergo the same rigorous review as private projects — even when the reviewing agencies have participated in the development of the restoration design. This process increased the cost of the project and often delayed construction by a year or more. The SWIM program, however, has made progress in streamlining the process based on its record of success, close monitoring and reporting to regulatory agencies, and monthly meetings with all jurisdictional agencies. Additionally, the new ERP process waives monitoring requirements for restoration projects.

Many bay managers believe that permitting is given too much emphasis in the regulatory arena, while monitoring and enforcement are short-changed. Lack of adequate enforcement personnel has been identified by the FDEP as a principal reason why so many mitigation projects required of private developers have either not been properly constructed, or constructed at all. This is true not only for mitigation projects, but also for stormwater facilities. The disparity is prevalent throughout the regulatory community, according to bay managers who responded to the estuary program survey, and may be as much a function of allocation of resources rather than the fault of the regulatory system itself. There are exceptions, such as Hillsborough County's EPC, which devotes a substantial portion of its resources to compliance and enforcement.

A NEW APPROACH TO BAY MANAGEMENT

Shrinking public funds, combined with increasing demands for government services and increasing public scrutiny of expenditures, are providing new challenges for resource managers. In the future, they will be pressed to spend money even more judiciously and on programs that yield quantifiable results.

Concurrently, attitudes about environmental management are shifting away from an emphasis on piecemeal oversight and toward a holistic view that assesses the cumulative impacts of human actions on entire natural systems. This approach is called "Ecosystem Management."

Many bay managers believe the amount of money spent on Tampa Bay is sufficient to adequately manage it, but that it should be redirected. In particular, they advocate a shift in some resources from permitting to monitoring and enforcement. They also support pro-active projects, such as habitat restoration, so long as these projects provide meaningful results and effectively address ecosystem needs. Support also is growing for cooperative partnerships such as team permitting, a concept that is being pursued by the FDEP as part of its Ecosystem Management initiative.

Those managers see Ecosystem Management as more effective than traditional resource management, since it relies less on micro-reviews of individual permits and more on assessing overall impacts. A critical component of successful Ecosystem Management is using biological living resources -- such as seagrass, fish and scallops — as a measure of the bay's health. Such an approach allows regulators the flexibility they need to achieve realistic, long-term goals and provides taxpayers with a better benchmark to judge the return on their investments.

Ecosystem Management also emphasizes the role that watersheds and tributaries play in Tampa Bay's overall health. A new SWFWMD initiative will focus attention on these vital areas through the creation of "watershed teams" which will prepare and implement detailed plans for key watersheds.

Making Ecosystem Management a reality in the Tampa Bay watershed will require a strong management plan backed by a stronger administrative structure that is less cumbersome, more accountable, and committed to addressing ecosystem needs. Bringing this plan to life within the existing bay management structure will be an important focus of the Tampa Bay NEP in overseeing implementation of the master plan for Tampa Bay.